

**DEPARTMENT OF GEOLOGY**

<b>MODULE CODE</b>	<b>GLG2B10</b>
<b>MODULE NAME</b>	<b>Structural Geology and Plate Tectonics</b>
<b>CAMPUS</b>	<b>APK</b>
<b>EXAM</b>	<b>NOVEMBER 2015</b>

<b>Date</b>	<b>9 November 2015</b>
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<b>Internal Moderator</b>	<b>Dr Bertus Smith</b>
<b>External Moderator</b>	
<b>Duration</b>	<b>180 minutes</b>
<b>Marks</b>	<b>180</b>

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<b>Number of pages</b>	<b>7 (including front page)</b>
<b>Instructions</b>	<b>Answer all the questions</b>

November exam

GLG2B10 Structural Geology and Plate Tectonics

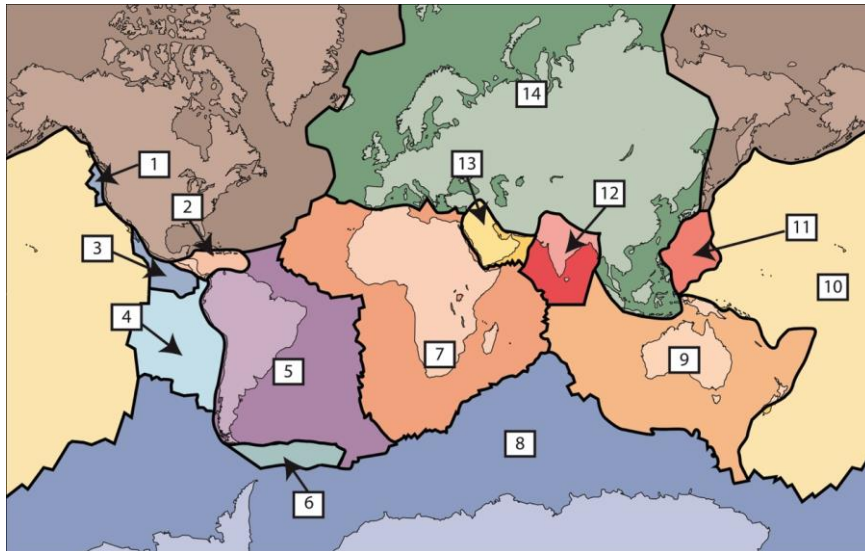
Section A: Plate Tectonics

Dr Herman van Niekerk

90 marks

Question 1

- a) Identify the numbered tectonic plates as indicated on the map below (7 marks):



- b) Name the type of plate tectonic boundary between the following tectonic plates in terms of it being convergent, divergent or conservative and name the geographical feature formed as a result (10 marks).
1. 4 and 5
  2. 5 and 7
  3. 12 and 14
  4. 4 and 10
  5. 8 and 7
- c) Give the reason for the formation of the following geographical features in terms of plate tectonic processes

1. Lake Victoria (1)
2. Iceland (2)
3. Lake Baikal (1)
4. Island of Hawaii (1)
5. Aleutian Islands (1)
6. Gulf of Aden (1)
7. Island of Japan (1)
8. Sea of Japan (1)
9. Rhine Valley (1)
10. Everest, K2, Makalu and Lhotse (1)
11. Mount Saint Helens and Mount Rainier (1)

### Question 2

- a) Name the different types of seismic waves associated with earthquakes and indicate which of these are responsible for damage caused during seismic events (7 marks)
- b) Make a sketch that illustrates the internal structure of the earth, and along with this sketch indicate the S-wave velocities. Be sure to indicate the depths at which the different components of the earth start and end (10 marks).

### Question 3

- a) Make a sketch and indicate the forces that act in on two plates in a subduction zone. Make sure to label the sketch properly (10 marks).

### Question 4

State whether the following statements are true or false (10 marks):

- a) Hotspot tracks are indicative of relative plate movements.
- b) The East Africa Rift is referred to as an active rift.
- c) The Alpine fault is responsible for many earthquakes in the United Kingdom.
- b) The mantle transitional zone can either be a mineral phase change or a fluid layer.
- e) The Atlas Mountains is an example of a continental island arc.
- f) The Rhine Graben is a mantle activated graben.
- g) Gondwanaland is made up of Laurasia and Pangea.
- h) The most destructive earthquakes are associated with mid oceanic spreading ridges.
- i) Paleomagnetism can be used to indirectly age date sedimentary rocks.
- j) The Edge Force mechanism model for convection cells driving plate tectonics is more effective in heat transfer than the Mantle Drag theory.

**Question 5**

Discuss the two possibilities behind the processes that drive plate tectonics. Use sketches to supplement your answers (10 marks).

**Question 6**

- a) Explain the difference between transform and transcurrent faults. Use sketches to supplement your answers (8 marks).
- b) Explain, and supplement with sketches why transform faults are often associated with extreme vertical relief (6 marks)

## Section 2 - Structural geology (90 Marks)

Total pages: 2

*Don't hesitate to use simple equations and/or simple sketches in your answers. And good luck!*

**Commented [SB1]:** This will be edited into a template so might not be applicable.

### 1. Stress and strain

- a. Define the terms:
  - i. mean stress,
  - ii. differential stress,
  - iii. effective pressure. (9)
- b. A geological object such as a fossil can be internally deformed (i.e. strained) during a tectonic event. Two types of strain end-members exist, pure shear (i.e. coaxial strain) and simple shear (i.e. non-coaxial strain). Explain by means of annotated (labelled) two-dimensional sketches the differences between these two end-members. (10)

### 2. Rheology (15)

In a differential stress vs. strain XY diagram, report as a schematic curve the behaviour of a marble sample that has been deformed and fractured during axial compression (triaxial test).

Annotate the diagram, and define the following below the diagram:

- yield strength,
- ultimate strength,
- rupture strength,
- domain of elastic strain,
- domain of plastic strain.

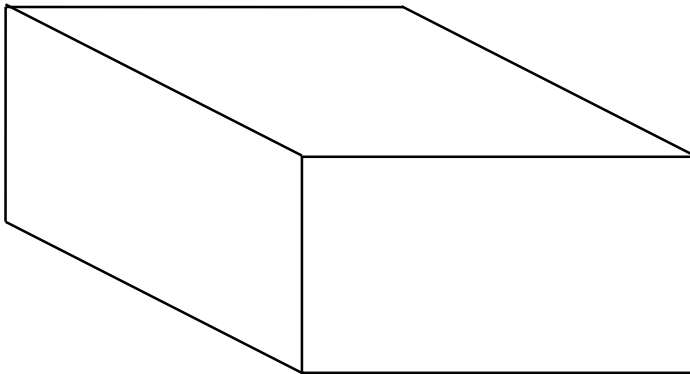
### 3. Ductile deformation

- a. Describe, with labelled sketches, the difference between an anticline, antiformal, synform and syncline. (16)
- b. Explain in which conditions and how the orientation of the finite shortening axis (i.e. the Z axis) can be retrieved from the shape of a fold. (10)

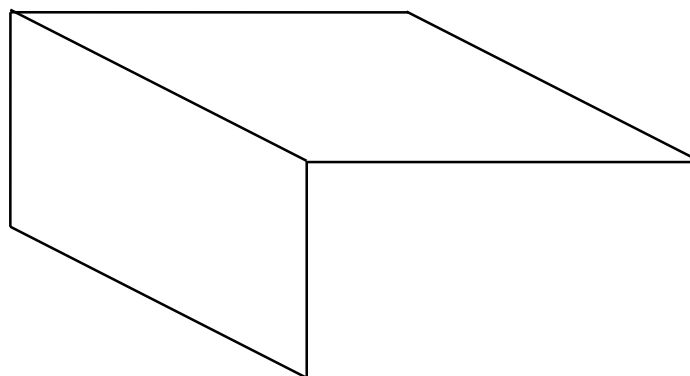
#### 4. Brittle deformation

- a. With a series of sketches using the 3D blocks below, indicate how high-angle normal faults, low-angle reverse faults and strike-slip faults are related to the three main stress components ( $\sigma_1$ ,  $\sigma_2$ ,  $\sigma_3$ ) according to Anderson's theory of faulting. (15).

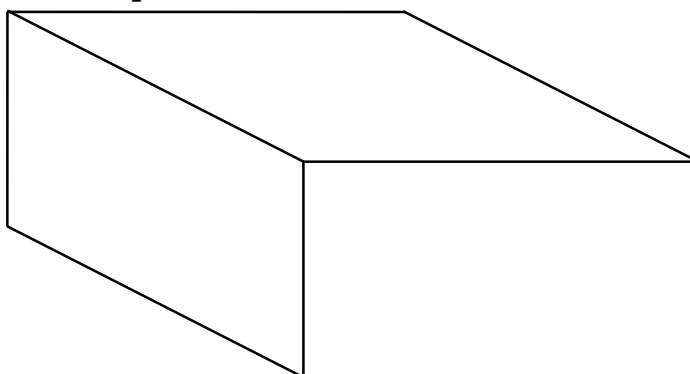
##### Normal fault



##### Reverse fault



##### Strike-slip fault



- b. After having reported these faults and the orientations of the principal stress axes as asked in question a above, draw the orientations of stylolites and tension gashes for the each of the above 3D blocks (15).